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An inventory of odonates of central Gujarat, India

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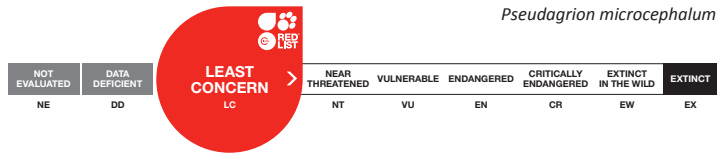
Abstract: An inventory of Odonata was carried out in six districts of central Gujarat from 2012 to 2014. A total of 42 species belonging to 27 genera, under seven families and two suborders were recorded. A total of 16 species of Zygoptera (damselflies) and 26 species of Anisoptera (dragonflies) were recorded. Anand District was surveyed intensively and as a result a maximum of 35 species was recorded (Dragonfly 22 and Damselfly 13), whereas less intensively surveyed districts, i.e., Panchmahal (17) and Dahod (16) had comparatively low species richness. Twenty-two species are being reported for the first time from central Gujarat, raising the total list of odonates to 48. Six species reported in an earlier survey were not encountered during this study. Seven species namely, *Copera marginipes, Pseudagrion microcephalum, Anaciaeschna jaspidea, Anax immaculifrons, Epophthalmia vittata, Brachydiplax sobrina, Tramea basilaris burmeisteri* are being recorded for the first time from Gujarat State. Hence, now the checklist of the odonates of Gujarat is raised to 65 species.

Keywords: Central Gujarat, diversity, inventory, odonates.

Globally 5,952 species of odonates are known and of this 474 species in 142 genera and 18 families exist in India (Subramanian 2014). Inventories of odonates in several neighboring states are available, including some regional studies within the same state, viz., Rajasthan (Bose & Mitra 1976; Prasad & Thakur 1981; Thakur 1985; Tyagi & Miller 1991; Prasad 2004; Koli et al. 2014), Madhya Pradesh (Mitra 1988; Mishra 2007) and Maharashtra (Prasad 1996; Kulkarni et al. 2006, 2012; Koparde et al. 2014). However, very little is known about the odonates of Gujarat State published by Asana & Makino (1935), Shull & Nadkarney (1967), Prasad (2004). Sharma (2009) published work on odonates of arid and semi-arid regions of India and listed 58 species from Gujarat based on the specimens available in museums. The document by Prasad (2004) lists about 48 species collected by ZSI scientists during a general faunistic survey of Gujarat State. However, no intensive study on the odonates of the specific area of Gujarat



Pseudagrion microcephalum

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State was undertaken. Gandhi (2012) in her doctoral thesis on terrestrial birds listed about 45 species of odonates from Vadodara District of central Gujarat but could reach species level identification of about 28 species. Though the entire odonates order is predacious and its all species are important as biological control agents of insect pests, there is no information (species list) available on the odonates of agro-ecosystems in Gujarat.

Central Gujarat has two major rivers (Sabarmati and Mahisagar) and their complex canal system in an intensively cultivated landscape is an ideal habitat for odonates.

Anand and Kheda districts with rice fields irrigated by the canals of the Mahi Right Bank Canal System and associated storage tanks should be very rich in odonate diversity. The paddy (*Oryza sativa*) crop agro-ecosystem is an ideal habitat for dragonflies. Since paddy is being grown in almost all of the districts, odonate diversity is likely to be very high in central Gujarat. Hence, to fill up the gaps in our knowledge about the diversity of Odonata in central Gujarat, particularly the paddy crop agro-ecosystems, the present inventory was planned.

Material and Methods

Study Area

An inventory of odonates was carried out in the wetlands and paddy fields of six districts of central Gujarat, i.e., Anand, Kheda, Vadodara, Ahmedabad, Panchmahal and Dahod from 2012 to 2014 (Fig. 1).

Two major rivers, Mahisagar and Sabarmati pass through central Gujarat making it a plain landscape. The northern part of the area has a common boundary with Rajasthan State. Ahmedabad District on its western side touches the Saurashtra region of Gujarat and Vadodara on the eastern side touches the Narmada and Bharuch of southern Gujarat. The southern side touches the Gulf of Khambhat. The area comprises plain land. The region has typical fertile soil popularly known as "*Goradu soil*" with loamy sand of alluvial origin, known for its productivity. Irrigation facility through Mahi Right Bank Canal is available to Anand and Kheda districts since 1960 and hence, intensive cropping is practiced throughout the year. The northern parts of Ahmedabad

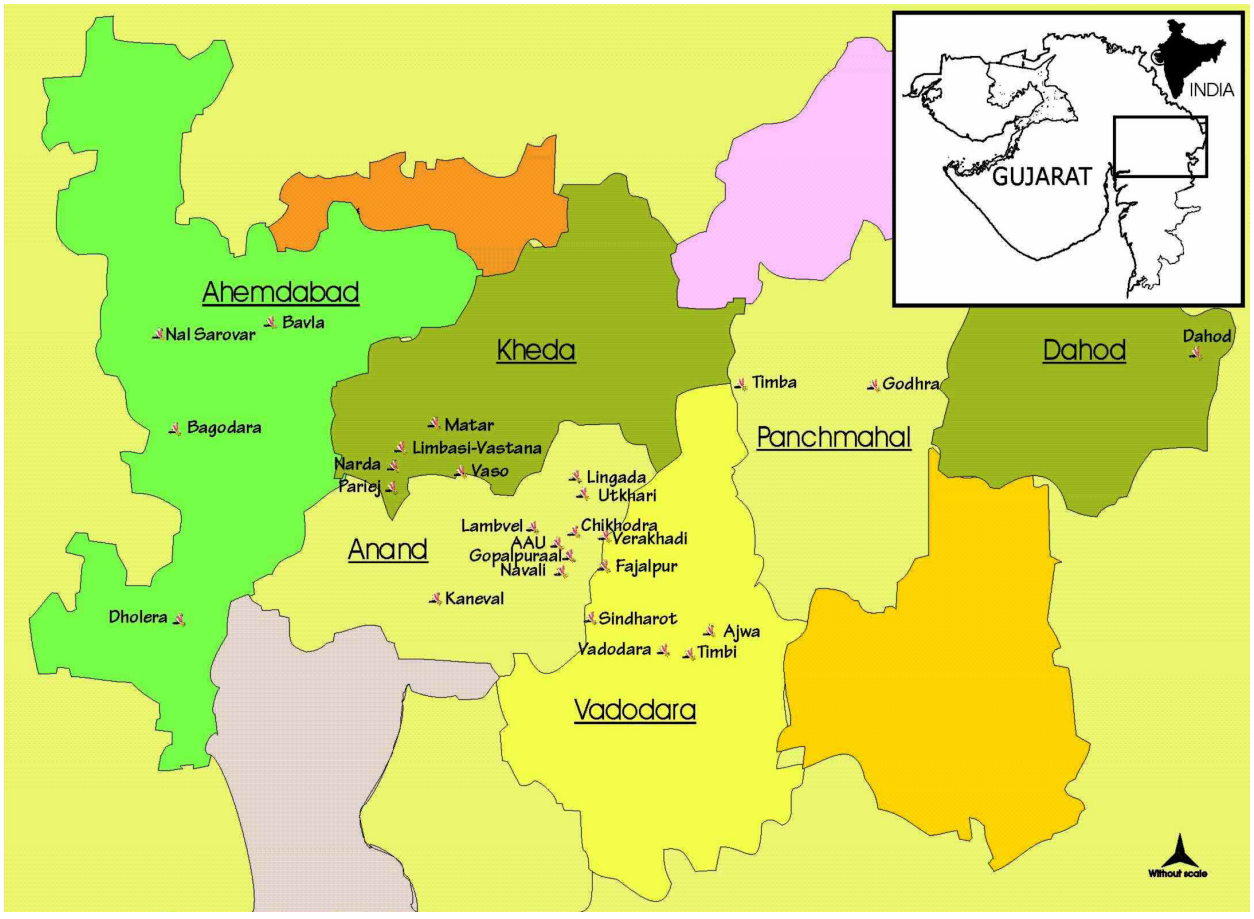

Figure 1. Study area showing six districts of central Gujarat and collection sites

District receive irrigation through Fatehwadi canals of Sabarmati River. On the western edge of Ahmedabad is the Nalsarovar Bird Sanctuary—a natural wetland spread over 120km^2. A complex network of irrigation canals and associated tanks, village ponds and paddy fields are ideal habitats for the odonates.

Anand, Kheda and Ahmedabad districts have alluvial sandy loam to sandy clay loam soil and extensive canal irrigation facilities, so this areas largely under paddy cultivation during the Kharif season (June to October). There is no forest cover in these three districts. On the other hand, Vadodara, Panchmahal and Dahod districts have shallow to deep black soil type, very little canal irrigation facility and paddy is grown in a very small area during the Kharif season. All the three districts have deciduous tree cover. Some of the protected areas are Jambughoda Wildlife Sanctuary (138.4km^2) of Panchmahal District and Ratanmahal Wildlife Sanctuary (55.7km^2) of Dahod District.

The climate of the region is semi arid, tropical monsoon type. Southwestern air currents in the summer bring monsoon rain from the third week of June to the end of September. The climate of the area is influenced by its surrounding regions through which the cold wind blows from the northern side of India. The average annual rainfall is 840mm received within a total of 35 days. The average monthly maximum temperature ranges between 40.1^{0}C (during April) to 26.3^{0}C (during January). The average monthly minimum temperature ranges between 8.6^{0}C (during January) to 27.9^{0}C (during June). The meteorological data of the remaining district is very close to the data of Anand.

Methods

Adult, free flying odonates were collected from all types of wetlands in the study area using a standard insect net. The specimens were killed in an insect killing jar and preserved in 70% alcohol. The specimens were kept separate by placing them in envelopes, labeled properly with details like species, date and place of collection. Extra specimens were preserved dry following standard procedure.

Only one collection was made from Panchmahal and Dahod during the study period. Repeated collections were made in the remaining four districts.

The specimens were identified with the help of photographic guides (Emiliyamma et al. 2005; Subramanian 2009; Nair 2011) and a suitable taxonomic book (Fraser 1933, 1934, 1936). The scientific names are adopted from the revised nomenclature given by Subramanian (2014). The specimens were taken to the Central Zone Regional Center, Zoological Survey of India, Jabalpur where one of us (SST) confirmed the identities of the specimens.

Results and Discussion

Inventory of odonates

During the study period, 42 species belonging to 27 genera, under seven families, and two suborders were collected from six districts of central Gujarat (Table 1). A total of 16 of Zygoptera (damselflies) and 26 species of Anisoptera (dragonflies) were recorded. In this study, Zygoptera was represented by three families and Anisoptera was represented by four families.

Inventory within central Gujarat

Anand District was surveyed intensively and as a result a maximum of 35 numbers of odonate species were recorded (Dragonfly 22 and Damselfly 13). Vadodara District having 28 species ranked second (Dragonfly 17 and Damselfly 11). Kheda (Dragonfly 17 and Damselfly 10) and Ahmedabad (Dragonfly 13 and Damselfly 7) districts ranked third and fourth respectively. In Panchmahal (17) and Dahod (16), species richness was comparatively low (Table 2). A total of 42 species of odonates were recorded from central Gujarat (Table 1). Among these, 16 species (38.09%) were Zygoptera and 26 species (61.90%) were Anisoptera.

In the present study (Table 1), 10 species were most common as they were recorded in all six districts; they were *Ceriagrion coromandelianum*, *Enallagma cyathigerum*, *Agriocnemis pygmaea*, *Orthetrum sabina*, *Acisoma panorpoides*, *Brachythemis contaminata*, *Crocothemis servilia*, *Trithemis aurora*, *Trithemis pallidinervis* and *Bradinopyga geminata*. *Diaplacodes trivialis* was present in five districts (Anand, Kheda, Vadodara, Ahmedabad, and Dahod) and *Pseudagrion decorum* was recorded in four districts (Anand, Kheda, Vadodara and Panchmahal) suggesting that they also may be common and abundant in all districts. At least five species were present in three districts but their presence could not be confirmed in the remaining three districts, probably due to the limited number of surveys in the respective districts. Nine species were recorded only from two adjoining districts. A total of nine species was recorded from a single district. Those species occurring in only one or two districts may be habitat specialists.

Comparison with earlier study

Prasad (2004) had reported a total of 26 species of odonates from central Gujarat. His records of odonates

Table 1. A comparison of odonates collected from central Gujarat (present study) with species list of Gujarat by Prasad (2004). Species marked with asterisk (*) are first record for the Gujarat State.

Taxon	Present study						Prasad (2004)
	Anand	Kheda	Vadodara	Ahmedabad	Panchmahal	Dahod	
Suborder: Zygoptera							
Superfamily: Lestoidea							
Family: Lestidae							
Lestes thoracicus Laidlaw, 1920			+				+
Lestes umbrinus Selys, 1891	+		+				+
Lestes virudulus Rambur, 1842	+	+		+			+
Superfamily: Coenagrionoidea							
Family: Platycnemididae							
**Copera marginipes* (Rambur, 1842)			+				
Disparoneura quadrimaculata (Rambur, 1842)			+		+		
Family: Coenagrionidae							
Agriocnemis pygmaea (Rambur, 1842)	+	+	+	+	+	+	+
Ceriagrion coromandelianum (Fabricius, 1798)	+	+	+	+	+	+	+
Enallagma cyathigerum (Charpentier, 1840)	+	+	+	+	+	+	+
Ischnura aurora (Brauer, 1865)	+	+	+				+
Ischnura elegans (Vander Linden, 1823)	+	+					+
Ischnura nursei (Mortan, 1907)	+	+	+	+			+
Ischnura senegalensis (Rambur, 1842)	+	+		+		+	+
Pseudagrion decorum (Rambur, 1842)	+	+	+		+		+
Pseudagrion hypermelas Selys, 1876	+						
**Pseudagrion microcephalum* (Rambur, 1842)	+	+	+				
Pseudagrion rubriceps Selys, 1876	+			+			
Suborder: Anisoptera							
Super family: Aeshnoidea							
Family: Aeshnidae							
**Anaciaeschna jaspidea* (Burmeister, 1839)	+						
Anax guttatus (Burmeister, 1839)	+	+	+	+			
**Anax immaculifrons* Rambur, 1842	+						

+ = present

Taxon	Present study						Prasad (2004)
	Anand	Kheda	Vadodara	Ahmedabad	Panchmahal	Dahod	
Superfamily: Gomphoidea							
Family: Gomphidae							
Ictinogomphus rapax (Rambur, 1842)	+	+	+			+	
Paragomphus lineatus (Selys, 1850)	+				+		+
Superfamily: Libelluloidea							
Family: Macromiidae							
**Epophthalmia vittata* Burmeister, 1839						+	
Family: Libellulidae							
Acisoma panorpoides (Rambur, 1842)	+	+	+	+	+	+	+
**Brachydiplax sobrina* (Rambur, 1842)	+	+	+	+	+		
Brachythemis contaminata (Fabricius, 1793)	+	+	+	+	+	+	+
Bradinopyga geminata (Rambur, 1842)	+	+	+	+	+	+	+
Crocothemis servilia (Drury, 1770)	+	+	+	+	+	+	+
Diplacodes lefebvrii (Rambur, 1842)	+	+	+		+		
Diaplacodes trivialis (Rambur, 1842)	+	+	+	+		+	
Neurothemis tullia (Drury, 1773)	+		+				
Orthetrum luzonicum (Brauer, 1868)					+		
Orthetrum pruinosum neglectum (Rambur, 1842)	+						+
Orthetrum sabina (Drury, 1770)	+	+	+	+	+	+	+
Orthetrum taeniolatum (Schneider, 1845)			+			+	+
Pantala flavescens (Fabricius, 1798)	+	+	+	+	+		
Rhyothemis variegata (Linnaeus, 1763)	+	+	+	+		+	
Tholymis tillarga (Fabricius, 1798)	+	+					
**Tramea basilaris burmeisteri* Kirbyi, 1889		+					
Trithemis aurora (Burmeister, 1839)	+	+	+	+	+	+	
Trithemis festiva (Rambur, 1842)	+		+				
Trithemis pallidinervis (Kirby, 1889)	+	+	+	+	+	+	+
Urothemis signata (Rambur, 1842)	+	+		+			

Table 2. Species richness of dragonflies and damselflies in central Gujarat

	Districts	No. of species		Total
		Dragonfly	Damselfly	
1	Anand	22	13	35 (83%)
2	Kheda	17	10	27 (64%)
3	Vadodara	17	11	28 (66%)
4	Ahmedabad	13	7	20 (47%)
5	Panchmahal	12	5	17 (40%)
6	Dahod	12	4	16 (38%)
	Total	26	16	42 (100%)

were largely from Ahmedabad (17 species), Kheda (13 species), Anand (4 species) and Vadodara (2 species) districts. In the present study, 42 species of odonates were recorded. Hence, in the present study 22 species are new records for central Gujarat.

Six species, i.e., *Copera ciliata, Enallagma parvum, Crecion calamorum, Onychargia atrocyana, Tramea virginia* and *Aethriamanta brevipennis* recorded earlier by him were not encountered during the present study. Combining the present inventory with the earlier one, the checklist of the odonates of central Gujarat touches 48 species. This is about 10 percent of the odonate diversity of India. Prasad (2004) did not report any odonates from Panchmahal and Dahod districts. Hence, in the present study, the record of 15 species from Panchmahal and 13 species from Dahod are first records for the respective districts.

Seven species namely, *Copera marginipes, Pseudagrion microcephalum*, *Anaciaeschna jaspidea*, *Anax immaculifrons*, *Epophthalmia vittata*, *Brachydiplax sobrina* and *Tramea basilaris burmeisteri* are first records for Gujarat State (Image 1). Hence, now the checklist of the odonates of Gujarat is raised to 65 species.

An intensive collection was done during the study period only in Anand District. As a result, the species richness of Anand District was the highest. Probably, species richness shown here was a reflection of the intensity of surveys rather than true ecological species richness. Due to limitations of resources and limited area search, the present list of odonates has remained below 10% of the total odonate species of India. In the present study, seven species of odonates are being reported for the first time from Gujarat. This was the first intensive study on the odonate diversity of Gujarat State.

Sharma (2009) has listed odonate species of arid and semi-arid regions of India, covering four states, i.e, Punjab, Haryana, Rajasthan and Gujarat. He had not carried out any survey in Gujarat but used the specimens available at the museums of IARI, New Delhi and ZSI, Dehradun and Jodhpur. The checklist provided by Sharma (2009) is a general list without mentioning place and date of collection. It is true that the major areas of Gujarat are arid or semi-arid but southern Gujarat is certainly a distinct part of the Western Ghats.

The Odonata checklist by Sharma (2009) includes all the species listed by Prasad (2004). Prasad (2004) has listed 48 species from Gujarat state with details of place of collection and date. In his list, at least nine species were exclusively collected from southern Gujarat which is climatically part of the Western Ghats evergreen forest and not a semi-arid zone.

Besides 48 species listed by Prasad (2004), Sharma (2009) has listed 10 more species for Gujarat. Amongst these 10 additional species, we too have come across following four species from central Gujarat; *Anax guttatus, Ictinogomphus rapax, Orthetrum luzonicum* and *Rhyothemis variegata.*

The only detailed list of the odonates of central Gujarat is based on the inventory of three wetlands of Vadodara District (Gandhi 2012, unpublished thesis). She has listed about 45 species; many of them identified only to genus level. Some of the species are neither listed by Prasad (2004) nor by Sharma (2009). On the other hand, out of 28 species listed in the present study, at least 11 species are not listed by her. It is likely that the list given in the thesis may be erroneous and the specimens collected needs confirmation of identification by an odonate taxonomist.

The value of odonates as indicators of the quality of the ecosystem is now being increasingly recognized. Odonates found in undisturbed habitats with good riparian vegetation were specialists with a narrow distribution range. On the other hand, the species recorded in industrial land or urban areas with disturbed riparian vegetation were generalists with a wide habitat preference and distribution (Subramanian 2009). Their studies also showed that dragonflies were sensitive not only to the quality of the wetland but also to the major landscape changes, especially changes in the riparian zone. Recent studies on dragonfly ecology from the Western Ghats indicated that families like Bambootails, Reedtails, Glories, Torrent Dart, Torrent Hawks and Clubtails are good indicators of the health of riverine ecosystems (Subramanian 2009). In the present study, Bambootail, Torrent Hawk and Clubtails were recorded only from Mahi River, the habitat which had the least anthropogenic disturbances.

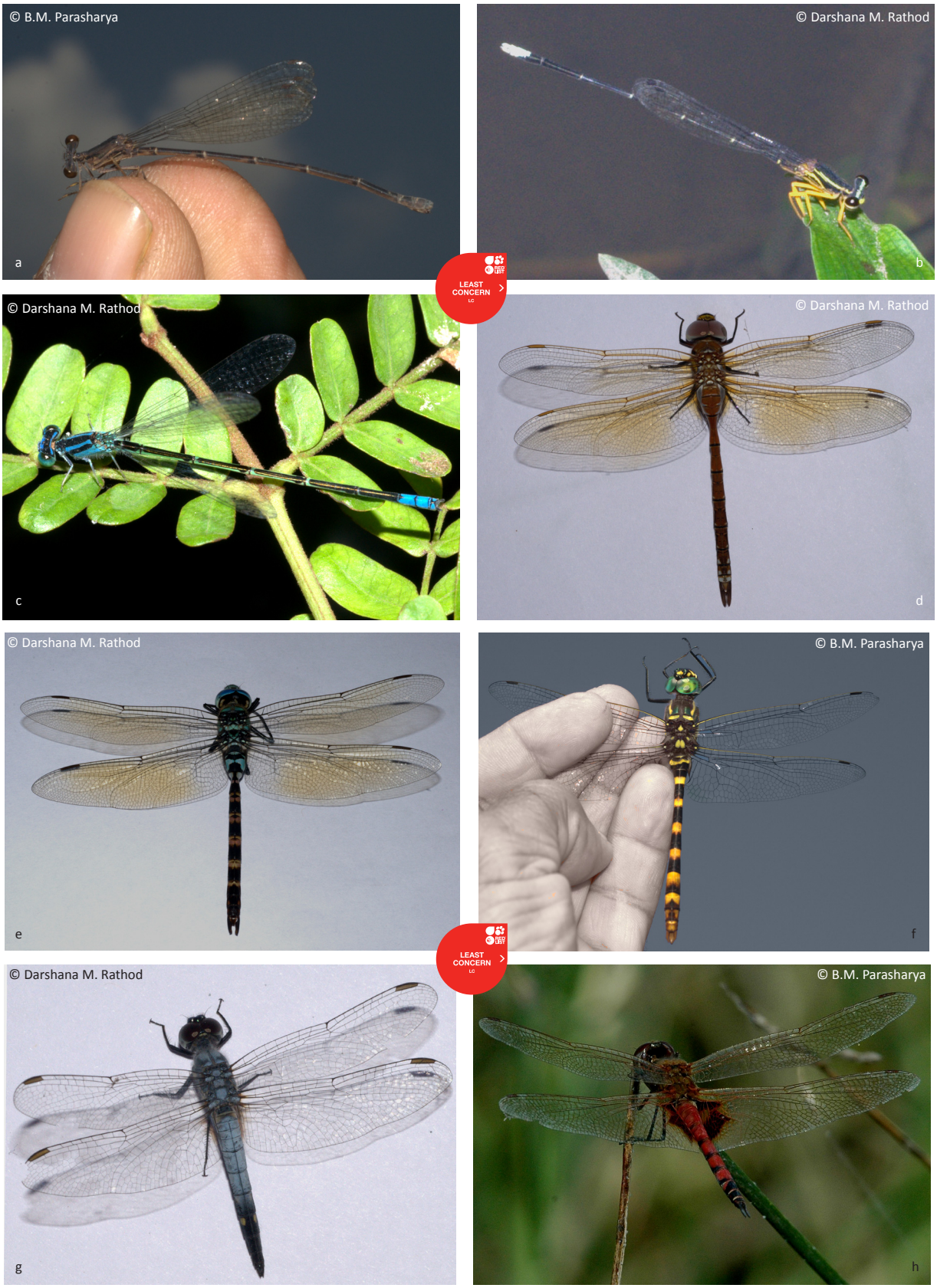

Image 1. Species recorded for the first time from Gujarat State
a - *Copera marginipes* (Female); b - *Copera marginipes* (Male); c - *Pseudagrion microcephalum*; d - *Anaciaeschna jaspidea*; e - *Anax immaculifrons*; f - *Epophthalmia vittata*; g - *Brachydiplax sobrina*; h - *Tramea basilaris burmeisteri*

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